

Chapter Four

Existing Power System



Chapter Four: Existing Power System

TVA's existing power system provides 25,600 megawatts of dependable generating capacity in the summer—57 percent from coal-fired plants, 16 percent from hydro facilities, 13 percent from nuclear, 8 percent from combustion turbines, and 6 percent from pumped-storage hydro.

TVA will add two nuclear units in 1996 (Watts Bar Nuclear Plant Unit 1 and Browns Ferry Nuclear Plant Unit 3), which will bring the total capacity to 28,000 megawatts.

TVA's existing coal-fired plants will continue to provide the largest part of TVA's generating supply during the Energy Vision 2020 planning period. Although the 1990 Clean Air Act Amendments imposed significant requirements on utilities to reduce sulfur dioxide emissions, as well as other air pollutants, TVA is taking actions that will meet or exceed these requirements.

TVA operates approximately 16,000 miles of transmission lines to carry power from 42 generating sites to 750 wholesale delivery points. TVA also connects with 13 neighboring utilities at 57 different locations.

In 1994, TVA generated 134 billion kilowatt-hours of electricity—84 percent was wholesaled to distributors, with the balance to directly served industrial and federal customers. The total revenue from these sales was \$5.4 billion.

In 1988, TVA changed its wholesale rate design to meet several objectives, including equity, efficient operations, and competitiveness. Looking to the future, TVA recognizes that rates for electric services will have to be more flexible to meet customer and consumer needs and expectations.

This Chapter Includes:

- TVA Customers and Sales
- Generating Resources
- How Power Supply Decisions Are Made
- 1990 Clean Air Act Amendments' Impact on Generating Facilities
- Customer Service Programs/Demand-Side Management
- TVA's Transmission System
- TVA's Financial Condition and Results of Operation
- TVA's Electric Rate Structure

Existing Power System

TVA Customers and Sales

TVA is the nation's largest public power utility, generating more than 134 billion kilowatt-hours of electricity annually, enough power to supply three cities the size of New York City. Through 160 municipal and cooperative power distributors, TVA serves 7.7 million people in parts of 7 states.

Revenues from power sales totaled \$5.4 billion for fiscal year 1994. In addition, Congress provides appropriated funds (tax money) to TVA for regional resource and economic development and stewardship of the federal investment. Appropriations for fiscal year 1994 were \$140 million, or 2.6 percent of TVA's total budget. TVA's power program is self-financing, and Congress provides no funds for it.

TVA IS A POWER WHOLESALER

TVA is primarily a wholesaler of power. Wholesale power is delivered to 160 power distributors that, in turn, distribute electricity to homes and businesses within their service areas. These distributors are a diverse group. The largest distributor of TVA power, Memphis Light, Gas & Water Division, serves 360,000 customers with annual electric sales of almost 12 billion kilowatt-hours. Some of the smaller municipal systems serve 1,500 customers or fewer. Electric cooperatives range in size from 3,500 customers to 95,000 customers.

TVA also sells power directly to 54 industries that have large or unusual loads and to 10 federal installations. Together, these directly served customers account for about 16 percent of TVA's energy sales. The directly served industries include chemical, metal, paper, textile, and automotive manufacturers.

TVA also has arrangements for exchanging power with 13 neighboring electric systems with which it buys and sells power on an almost daily basis.

Figure 4-1 provides a breakdown of TVA customers and sales for fiscal year 1994.

TVA POWER EXCHANGES

TVA exchanges, or buys and sells power, with neighboring electric systems through 57 interconnections. The sale of power by TVA provides a way to earn revenue. The purchase of power is sometimes necessary to meet heavy demand; at other times, it may be more economical for TVA to purchase excess power from a neighboring utility than to generate it. TVA also "wheels" power

TVA is the nation's largest public power utility, generating more than 134 billion kilowatt-hours of electricity annually, enough power to supply three cities the size of New York City.

FIGURE 4-1. TVA Customers and Sales for Fiscal Year 1994

	Customers	Annual Energy (Millions of kWh)	Estimated Impact on Annual Peak (MW)
DISTRIBUTOR SERVED SALES			
Residential	3,068,076	46,330	11,900
Commercial	501,198	33,408	5,400
Manufacturing	3,036	23,101	2,900
Outdoor Lighting	14,216	1,235	0
Direct-Served Industrial Sales	54	16,706	1,700
Direct-Served Federal Sales	10	2,309	700
Other Sales and Losses		11,077	1,800
Total Requirements		134,166	24,400

TVA wholesales electricity to power distributors and sells electricity directly to some large industrial customers and federal agencies. In addition, TVA at times sells power to neighboring utilities who are connected to the TVA power transmission system. Figure 4-1 shows the number of customers served by distributors and TVA and the electricity sales to each group.

at a fee for other utilities. Wheeling is transporting power from one utility to another through TVA's transmission system.

For fiscal year 1994, power exchanges with other utilities were as follows:

- **Sales to other utilities** – 8.6 billion kilowatt-hours (6 percent of TVA's total sales)
- **Purchases from other utilities** – 8.2 billion kilowatt-hours
- **Wheeling transactions** – 0.9 billion kilowatt-hours

It is interesting to note that in 1988, TVA was a net purchaser of power at a cost of \$330 million. In 1992, TVA became a net seller, producing off-system sales revenue of almost \$95 million. By 1994, revenue from net sales climbed to \$193 million. This increase in sales can be attributed to improvements in TVA's generating system, increasing both efficiency and production capacity.

Generating Resources

TVA currently has 25,600 megawatts of generating capacity. Electricity is produced through a combination of coal-fired, hydroelectric, nuclear, combustion turbine, and pumped-storage hydro plants. *Figure 4-2* shows the capacity mix and the percentage of capacity supplied by each type of generation.

TVA plans to begin operating Watts Bar Nuclear Plant Unit 1 and Browns Ferry Nuclear Plant Unit 3 in 1996, which will add 2,235 megawatts of generating capacity to the power system. Other adjustments to generating capacity will include improvements to the hydro and coal-fired plants and the sale of steam, bringing total capacity to 28,000 megawatts in 1996.

FIGURE 4-2. TVA's 1994 Capacity Mix

Type of Capacity	Megawatts	Percent
Conventional Hydro	4,044	16
Pumped-Storage Hydro	1,532	6
Coal	14,743	57
Combustion Turbines	1,952	8
Nuclear	3,282	13
TOTAL	25,553	100

TVA produces power from a number of different types of generating sources. This chart shows the generating capacity for various types of resources and the percentage of TVA's overall generating capacity provided by each.

In addition to conventional power generation, TVA has more than 2,500 megawatts of interruptible power contracts that allow TVA to interrupt power to industrial customers during peak load periods. This interruptible power is used as part of TVA's available capacity; however, due to variations in industrial plant operations, not all of the contracted power is available for interruption at the same time. Typically, about 1,700 megawatts of industrial load reduction are available at peak times.

TVA's generating sources are a diverse mix that offers TVA a distinct advantage over many other utilities. The varied mix provides a buffering effect that helps TVA absorb the impacts of changes that affect only one particular

type of generation, such as more stringent nuclear regulations or coal-fired air emission reduction requirements. By “averaging” the impacts across the system, the effects are greatly reduced compared to a utility that is chiefly dependent on a single type of generating source.

A description of TVA’s various generating resources—hydro (conventional and pumped-storage), coal-fired, combustion turbine, and nuclear plants—follows. Generating capacity for fiscal year 1994 is included for each source of production.

TVA’S HYDRO SYSTEM

The TVA hydro system includes 109 conventional hydroelectric generating units and four pumped-storage units at Raccoon Mountain Pumped-Storage Facility. These conventional hydro units are located at 29 sites along the Tennessee River and its tributaries.

Hydro capacity is 4,044 megawatts, which includes 405 megawatts available from the U.S. Corps of Engineers’ hydro generating plants along the Cumberland River and 321 megawatts from Aluminum Company of America plants. Aluminum Company of America owns hydro plants located on tributaries of the Tennessee River, and TVA operates these plants as part of its power supply system.

Hydro generating capacity will be increased as the result of ongoing modernization projects. Upgrades and improvements at TVA’s plants will add approximately 360 megawatts of capacity by 2005, while improving the efficiency of these plants by 3 percent.

COAL-BURNING POWER PLANTS

TVA has 59 active coal-fired units located at 11 plant sites throughout the Valley. The coal-fired units range in size from 107 megawatts for each of the Johnsonville units 1-4 to 1,224 megawatts for each of the two units at Cumberland. The oldest active coal unit was placed in service in 1951, and the newest unit is Cumberland 2, which began operation in 1973. A recent review identified no technical problems that would prevent the continued operation of these generating units through the study period covered by Energy Vision 2020.

TVA’s coal-fired units have a combined capacity of 14,743 megawatts. TVA anticipates some minor reductions in coal system capacity as the result of the installation of pollution control equipment and the sale of steam, rather than electricity, to a DuPont facility adjacent to TVA’s Johnsonville Fossil Plant.

COMBUSTION TURBINES

TVA has 48 combustion turbine units that are located at four coal-fired plant sites. Of this total, 28 are capable of burning natural gas or oil. The other 20 units have the capability to burn oil only. The combined capacity of these combustion turbines is 1,952 megawatts. The average age of TVA’s combustion turbine units is approximately 23 years, and all units are anticipated to be available throughout the study period of Energy Vision 2020.

TVA recently upgraded the reliability of its combustion turbines, which has reduced the forced outage rate, a measurement of reliability.

NUCLEAR GENERATION

Five nuclear units, located at three sites, are included in TVA's existing inventory of supply resources: Browns Ferry Nuclear Plant Units 2 and 3, Sequoyah Nuclear Plant Units 1 and 2, and Watts Bar Nuclear Plant Unit 1. Total generating capacity of the three operating nuclear units is 3,282 megawatts. Watts Bar Nuclear Plant Unit 1 was granted a license to load fuel and perform low power testing in November 1995. Fuel loading was completed in November, and Watts Bar Nuclear Plant Unit 1 is expected to begin commercial operation in spring 1996. Browns Ferry Nuclear Plant Unit 3 fuel load was completed in October and it is scheduled to return to service in early 1996. These units are considered part of TVA's existing power system for the purposes of Energy Vision 2020.

The two units coming on line in 1996 will provide an additional 2,235 megawatts of generating capacity. Operating Watts Bar Nuclear Plant Unit 1 and Browns Ferry Nuclear Plant Unit 3 will help meet projected future loads on the TVA power system at a very economically competitive cost. As of March 31, 1995, TVA's undepreciated investment in these two units was approximately \$6.8 billion and \$1.8 billion, respectively. Both Watts Bar Nuclear Plant Unit 1 and Browns Ferry Nuclear Plant Unit 3 will be revenue-producing assets when they go into operation. The construction expenditures on these units will be depreciated, and the depreciation costs will be recovered in revenues. Revenues will exceed the depreciation, fuel, and operations and maintenance expense at the plants. Operating the plants will allow TVA to begin earning a return on the agency's investment in the form of generation from Watts Bar Nuclear Plant Unit 1 and Browns Ferry Nuclear Plant Unit 3.

Compared to purchasing power or meeting demand with coal-fired generation or combustion turbine units, operation of these two nuclear units will be among TVA's lowest cost generating sources. Operating costs for Watts Bar Nuclear Plant Unit 1 and Browns Ferry Nuclear Plant Unit 3 are projected to be approximately 1.7 cents per kilowatt-hour. In contrast, the operating costs of alternative generating sources would range from 2.0 to 6.0 cents per kilowatt-hour.

TVA's nuclear performance has improved considerably during the past several years. The performance of Browns Ferry Nuclear Plant Unit 2 has been excellent since the plant was restarted in 1990. Performance at Sequoyah, while not reaching the same levels of excellence, has also had significant high points, including being ranked as one of the top nuclear plants in the country for net generation and setting the TVA record for longest continuous run by a large generating station in 1991. The combined capacity factor for TVA's three operating units for fiscal year 1995 was 80 percent.

While TVA has scaled back its nuclear construction program, nuclear generation will continue to play a vital role in helping provide economical power generation.

Detailed information on all of TVA's generating resources, such as plant locations, capacity, and performance and cost characteristics (including decommissioning cost for nuclear) can be found in Volume 2, Technical Document 3, Existing Power System.

How Power Supply Decisions Are Made

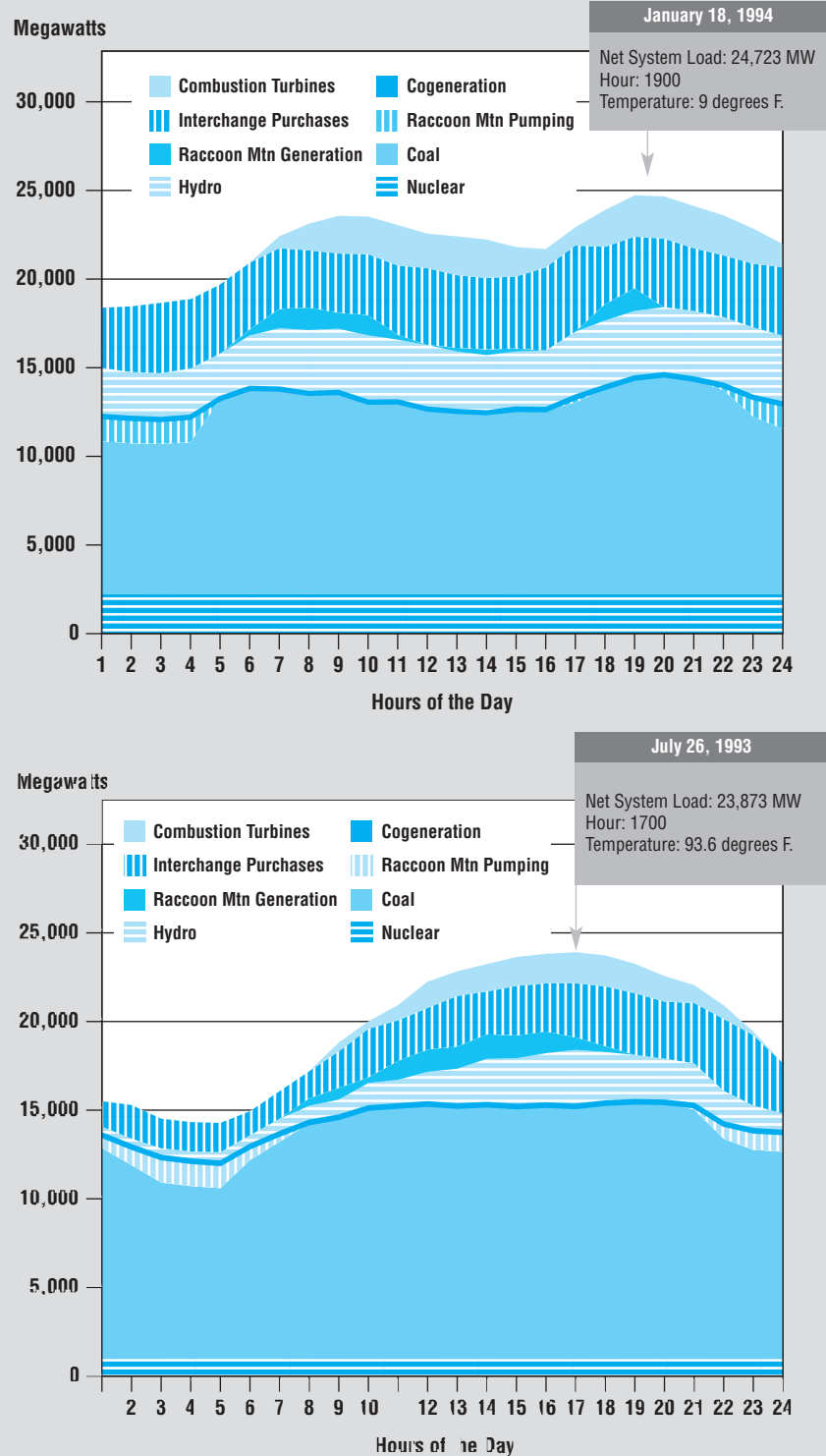
Though TVA has the capacity described in the previous section, the actual use of these energy sources varies depending on costs, weather, customers' needs, and other factors such as operating constraints of a particular power generation source.

Power from TVA's various generation sources is dispatched, or distributed, to meet the demand for electricity at the lowest cost. The primary factor in determining generating mix at any particular time is fuel costs. However, variable operation and maintenance costs (costs that vary with the power output of the various generating units) are added to the fuel costs in dispatching generating units. In addition, beginning in 1995, the economic value of the allowances required to emit sulfur dioxide from some TVA sources is included in making dispatching decisions.

Figures 4-3 and 4-4 show the dispatch of the system for the 24-hour periods of January 18, 1994, and July 26, 1993. These dates represent the all-time winter and summer peak demand on the TVA power system and illustrate how various power production sources are brought on line to meet energy demands.

The hydro resources are the least expensive to operate because they have no fuel costs. Hydro resources provide an economical way to reduce the amount of generation required from other, more expensive generating sources during periods of high demand. Hydro resources are not used continuously because they are limited by the amount of rainfall and runoff into the storage reservoirs or

FIGURE 4-3 & 4-4. TVA Load and Supply



Generating resources are brought on line as needed to meet customer demand for electricity. Since power production costs vary, depending on the generating source, plants are brought on line in the most economical sequence. These figures illustrate how the need for power was met during days of winter and summer peak demand.

lakes in the Tennessee Valley. There is significant variation in the amount of hydro output available from week to week and year to year based on the amount of rainfall. Hydro resources also must be operated under constraints to meet the needs of flood control and navigation, and take into account recreation and tourism effects.

Pumped-hydro capacity at the Raccoon Mountain Plant is used to meet peak requirements, as well as to satisfy other system needs such as operating reserve. The operating characteristics of a pumped-storage facility, however, make it a limited resource. The amount of generation is limited by the amount of water in the storage pond at the top of the mountain. This storage pond supports only a set number of hours of operation at full output. In addition, TVA's ability to pump water back into the storage pond may be affected at times by reduced availability of low-cost power to operate the pumps.

Energy production from hydro plants was 20.2 billion kilowatt-hours for fiscal year 1994, accounting for 15.4 percent of TVA's generation. This includes the net pumped-hydro generation from Raccoon Mountain and hydro generation received from the Corps of Engineers and Aluminum Company of America.

Nuclear generation is operated as much as possible, since its fuel costs are relatively low. Another consideration is the physical operating constraints of nuclear plants. Nuclear units are not easily cycled—meaning they cannot be brought on line quickly and the output of energy cannot be adjusted quickly compared to other sources. Hydro is, in contrast, a resource that can respond almost immediately to changes in demands for power. Therefore, nuclear generation is principally used as part of TVA's "base load." Base load is the minimal amount of power that must be available around the clock to meet demand.

Energy produced by TVA's nuclear plants during fiscal year 1994 totaled 18.4 billion kilowatt-hours, or 14 percent of all energy produced by TVA.

Coal-fired generation provides the bulk of TVA's power supply, representing more than 50 percent of the available generating capacity. Coal-fired units do vary in operating costs, depending on the technology at the various plants and the type of coal used by the generating units (high-sulfur coal or low-sulfur coal). In addition, some coal-fired plants, like nuclear units, are not designed to be brought on or off line quickly, and the output of energy is not readily adjustable.

TVA's coal-fired plants supplied 92.1 billion kilowatt-hours during fiscal year 1994, which was 70.4 percent of the total energy supply.

Combustion turbines are relatively high in cost to operate. Combustion turbine units operate on natural gas or fuel oil, both high-cost fuel sources. In addition, TVA's combustion turbines have lower efficiency compared to other types of generating resources. They are used sparingly to meet peak demands.

Energy production from combustion turbines during fiscal year 1994 was 0.2 billion kilowatt-hours, or 0.2 percent of all electricity generated.

1990 Clean Air Act Amendments' Impact on Generating Facilities

The 1990 Clean Air Act Amendments imposed new requirements on the utility industry. The most significant of these requirements derive from the “acid rain” provisions of the amendments, which require the United States electric utility industry to reduce its emissions of sulfur dioxide and nitrogen oxides. Utilities, such as TVA, that burn significant amounts of coal to generate electricity have substantial emission reduction obligations.

SULFUR DIOXIDE CONTROLS

The sulfur dioxide portion of the “acid rain” provisions also introduced on a national scale a new approach to environmental regulation. This approach is intended to reduce the overall cost of achieving the environmental objective by setting a national cap for utility sulfur dioxide emissions and establishing a mechanism to allow emissions reductions to come from the sources that can achieve these reductions at least cost.

The Environmental Protection Agency annually issues to each regulated source a number of sulfur dioxide “allowances” based on the sulfur dioxide annual average emission rate for each fossil unit in 1985 and the amount of coal burned during the baseline period of 1985 through 1987. (One “allowance” gives the source permission to emit one ton of sulfur dioxide.) A source’s reduction obligation, the difference between baseline sulfur dioxide emissions and the number of allowances issued by the Environmental Protection Agency, can then be met by either reducing emissions from that source or by ensuring, through allowance transfers, that equivalent reductions are made at another source(s). A source is deemed to be in compliance if, at the end of the year, it holds enough allowances to cover its sulfur dioxide emissions.

Thus, utilities can choose to make “excess” reductions at one or more sources while either (a) making lesser or no reductions at other units on their system that are less economical to control, (b) selling the excess allowances to other utilities, or (c) banking the excess allowances for use in future years. Conversely, a utility could choose to take lesser or no reductions and achieve compliance by buying allowances from others.

Sulfur dioxide emissions are to be reduced in two phases according to the Clean Air Act Amendments. The larger and more polluting utility units are required to reduce sulfur dioxide emissions in Phase I. Phase I sources generally were to be in compliance by January 1, 1995. In Phase II, the remainder of utility sources become subject to sulfur dioxide reductions, and the allowances issued by the Environmental Protection Agency to the Phase I affected sources will be reduced. All sources must be in substantial compliance with Phase II requirements by January 1, 2000.

Twenty-six of TVA’s 59 operating coal-fired units are Phase I units. Its remaining coal-fired units are Phase II sources. To date, TVA’s approach has been

not to rely on the ability to buy allowances from other sources to achieve its reduction obligations. The TVA system is large enough that it can take advantage of the flexibility available under the allowance program to substantially reduce its cost of compliance.

TVA has already completed the actions necessary to achieve Phase I compliance. Sulfur dioxide emissions control equipment has been installed on TVA's largest Phase I generating units, units 1 and 2 at Cumberland Fossil Plant. This \$535 million project included the installation of wet limestone flue gas desulfurization equipment (scrubbers). These scrubbers reduce Cumberland's sulfur dioxide emissions by approximately 95 percent. Other control measures have included the switch to lower sulfur coal at TVA's Allen Fossil Plant in Memphis. Through these actions, TVA will meet its reduction obligations for all 26 affected units through Phase I and have excess reductions banked for use during Phase II.

NITROGEN OXIDES REDUCTION

Utility sources subject to Phase I sulfur dioxide reductions must, in general, also achieve nitrogen oxides reductions during Phase I. There is no national cap and allowance system comparable to the sulfur dioxide reduction program for nitrogen oxides. Nitrogen oxides compliance is based on an allowable emission rate determined by the boiler type. However, flexibility is provided within a utility system to include multiple units within an "averaging plan" that would allow excess reductions at one or more units to offset lesser reductions at others.

Nitrogen oxides reductions are required at 19 of TVA's 26 Phase I units. (The remaining seven units, because of their boiler type, will be subject to reductions during Phase II.) These reductions have already been achieved by installing low-nitrogen oxides burners at 13 of the 19 units. On 4 of these 13 units, separated over-fire air, a supplemental nitrogen oxides control technology, has also been installed to achieve additional reductions. As with sulfur dioxide, TVA will achieve nitrogen oxides compliance on a system-wide basis by using an "averaging plan."

TVA is proceeding to install low-nitrogen oxides burners at many of its Phase II units in advance of the year 2000 regulatory deadline. Installation of burners is either accomplished or planned for the John Sevier, Kingston, and Widow's Creek Fossil Plants. (TVA has a total of 40 generating units that will be subject to Phase II nitrogen oxides reduction requirements.)

COSTS

Total estimated cost for the pollution control measures required for acid rain compliance will be approximately \$2.3 billion dollars. By the end of fiscal year 1995, \$770 million will have been spent. Operating cost increases associated with these actions will exceed \$300 million per year.

OTHER CONSIDERATIONS

TVA has not incurred significant costs or liabilities from other provisions of the 1990 Clean Air Act Amendments. The Nashville/Davidson County area currently exceeds the allowable levels for ambient ozone concentration. The State of Tennessee must develop plans acceptable to the Environmental Protection Agency to reduce ambient ozone concentrations to acceptable levels. This could have required nitrogen oxides reductions from the Gallatin Fossil Plant. (Nitrogen oxides react with other chemicals in the air to form ozone. The Gallatin plant is within the Nashville/Davidson County area.) However, Tennessee has accepted the nitrogen oxides reduction installation at the Gallatin Fossil Plant as meeting the nitrogen oxides reductions required by their plan.

Other ways the 1990 Clean Air Amendments may affect TVA are discussed in Chapter 3, Affected Environment.

Customer Service Programs/Demand-Side Management

Customer service and demand-side management programs have been a part of TVA's energy supply resource mix since the late 1970s. These programs promote energy conservation and the efficient use of electricity. They were initiated in response to the rising cost of energy and the rising cost of building new electric generating units that began in the mid-1970s.

These programs provide benefit to both the end-use consumer through reduced energy costs and to TVA by avoiding the need for additional generating capacity. By 1988, these programs were credited with saving more than 2,300 million kilowatt-hours per year and cutting TVA's system demand by 1,200 megawatts. *Figure 4-5* shows the savings associated with each of these programs, the benefits of which continue today.

Through the years, the economics of TVA's conservation and energy management programs began to change. More than 631,000 Valley homes were weatherized during the 1980s under the Home Insulation Program; this was the backbone of TVA's conservation programs. Building standards for energy efficiency in new homes began to rise as consumers learned of the benefits of improved weatherization techniques. By the late 1980s, TVA was approaching market saturation for its home weatherization program. At the same time, the supply of available power increased, both within TVA and from other utilities, causing TVA to begin a review of its customer service and demand-side management

FIGURE 4-5. Historical Customer Service Programs

Program	Units	Millions of Kilowatt-Hours	Megawatts
Sunscreens	5,000	4	-
Heat Pump Water Heater	2,000	5	1
Solar Water Heater	7,000	26	10
Cycle and Save	111,000	0	79
Energy Saver Homes	36,000	116	36
Wood Heaters	16,000	79	55
Heat Pumps	135,000	228	74
Home Weatherization	631,000	1,883	959
TOTAL		2,341	1,214

TVA served thousands of customers in the decade of the 1980s through programs designed to save energy and increase comfort. For example, 631,000 customers saved a total of 1,883 million kilowatt-hours of energy during the decade through home weatherization and reduced TVA's need for new capacity by 959 megawatts.

FIGURE 4-6. Impacts of Current Demand-Side Management Programs for 1995 – 1996

Program	Units	Millions of Kilowatt-Hours	Megawatts
RESOURCE ACQUISITION (Savings)			
Heat Pump	19,330	51.5	16.5
New Homes	5,857	4.6	1.3
Manufactured Homes	1,230	5.0	1.6
Interruptible Rates		N/A	1,700.0
Direct Load Control	96,850	N/A	69.6
BENEFICIAL ELECTRIFICATION (Sales)			
Heat Pump	10,870	81.7	29.9
New Homes	3,143	21.1	1.4
Manufactured Homes	660	2.6	0

TVA's current programs include energy efficiency programs, a rate program, a direct load control program, and beneficial electrification programs. For example, the heat pump program includes both energy efficiency and beneficial electrification components, and results in a net increase in sales of 30.2 million kilowatt-hours. The interruptible rates and direct load control programs significantly reduce peak demand, but instead of reducing energy requirements, shift energy usage from peak periods to off-peak periods.

programs to make sure that they were still cost-effective for TVA's ratepayers.

As a result of this review, TVA began reshaping its customer service and demand-side management programs during the late 1980s and early 1990s. While the early programs continue to benefit the power system, current initiatives are geared to assist consumers in making electricity a better value through the use of new electric technologies and techniques. Customer service offerings now include an electric heat pump program, a new homes program, a manufactured housing program, and a direct load control program. (This load management program shifts energy use to off-peak hours or periods of low demand for electricity, e.g.,

the cycling of appliances such as water heaters.) These programs, which are offered through participating distributors of TVA power, are currently scheduled to continue through 1996.

TVA also has rate programs for interruptible power for industrial customers, as discussed earlier in this chapter. This includes Economy Surplus Power (ESP), which is a real-time pricing program for interruptible load. Approximately 1,700 megawatts of industrial load is available for interruption during peak periods. In addition, TVA and participating distributors of TVA power provide a broad range of technical assistance to commercial and industrial customers to help them get the most value for their energy dollar. Some of these services include recommendations on efficient heating and cooling equipment, outdoor lighting systems, power monitor metering, power quality analysis, and preparation of feasibility/application studies for new electrotechnologies that offer opportunities for lower production costs and increased output.

Figure 4-6 shows the impacts of these current demand-side management programs—energy efficiency programs, a rate program, a direct load control program, and beneficial electrification programs. The values in Figure 4-6 are the impacts occurring only in the year 1996 for the cumulative participation in the program during 1995 and 1996.

TVA's Transmission System

TVA operates an interconnected transmission system capable of carrying power from its 42 generating sites to 750 wholesale delivery points and to 57 points of interconnection with neighboring power systems.

Figure 4-7 illustrates how power is delivered from generating plants to distributors to homes and businesses. Power from generating facilities is produced at low voltages, such as 24,000 volts, which are then generally boosted to 500,000 or 161,000 volts for delivery to wholesale and directly served customers through TVA's transmission system. At delivery points, this high voltage power is reduced at substations to voltages that can be sent through distribution lines to end users, where it is further reduced so that it can be used in homes and businesses.

The transmission system includes 12,200 miles of 161,000 and 500,000 volt transmission lines. These two overlaid networks are tied together at 25 locations through 500,000 and 161,000 volt substations located throughout the TVA service area. In addition, 3,800 miles of 69,000 and 46,000 volt lines are operated radially to serve dispersed load centers. Distributors accept power from TVA at voltages ranging from 161,000 to 13,000 volts and, in turn, distribute power at voltages ranging from 161,000 to 120 volts to small industries, commercial customers, and homes.

TVA's transmission system is also directly connected to 13 neighboring utilities with interconnection voltages ranging from 500,000 to 69,000 volts. These interconnections allow TVA and its utility neighbors to buy and sell power from each other and to wheel power through their systems to other utilities.

TVA's generation and transmission facilities are self-funded through power revenues. Improvements to the transmission system are planned and implemented to ensure continued reliability and service. The fiscal year 1995 budget for transmission system capital projects is approximately \$130 million. These include more than 150 active projects ranging from simple new delivery points (\$100-\$300 thousand) to major 500,000 and 161,000 volt substations (\$30-\$40 million) in Mississippi and Alabama.

Figure 4-8 provides an overview of the power system, including the 500,000 and 161,000 volt transmission lines, the generating plants (hydro, fossil fuel,

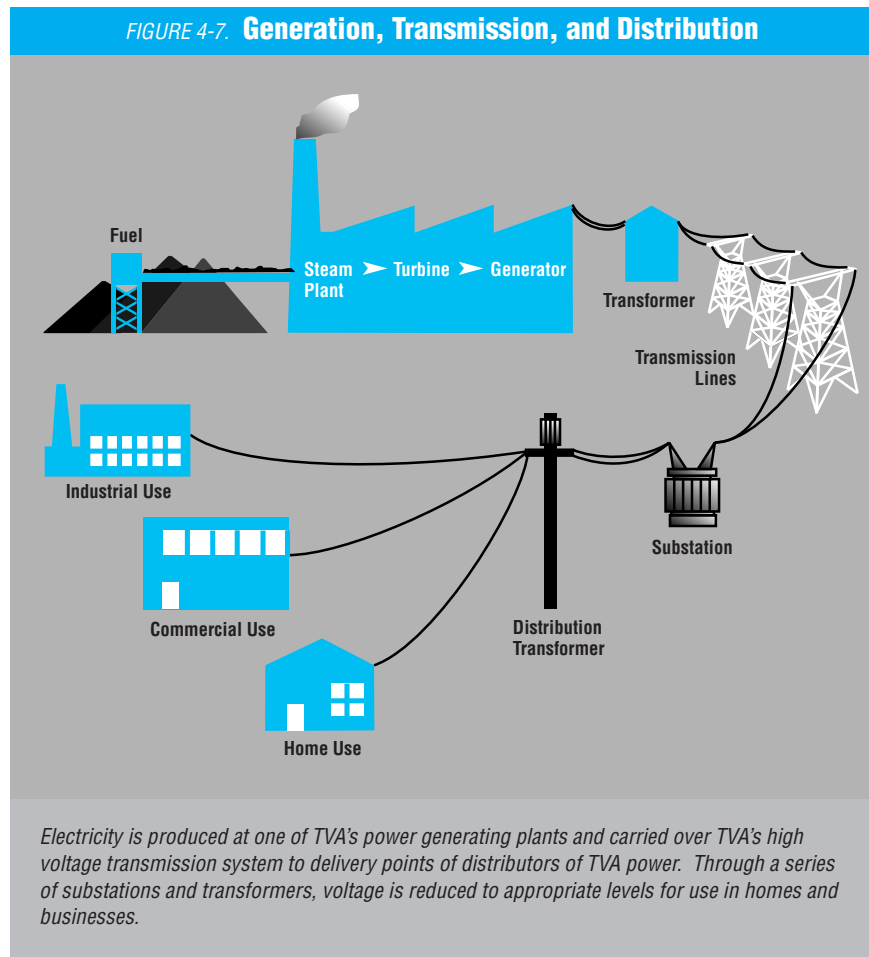
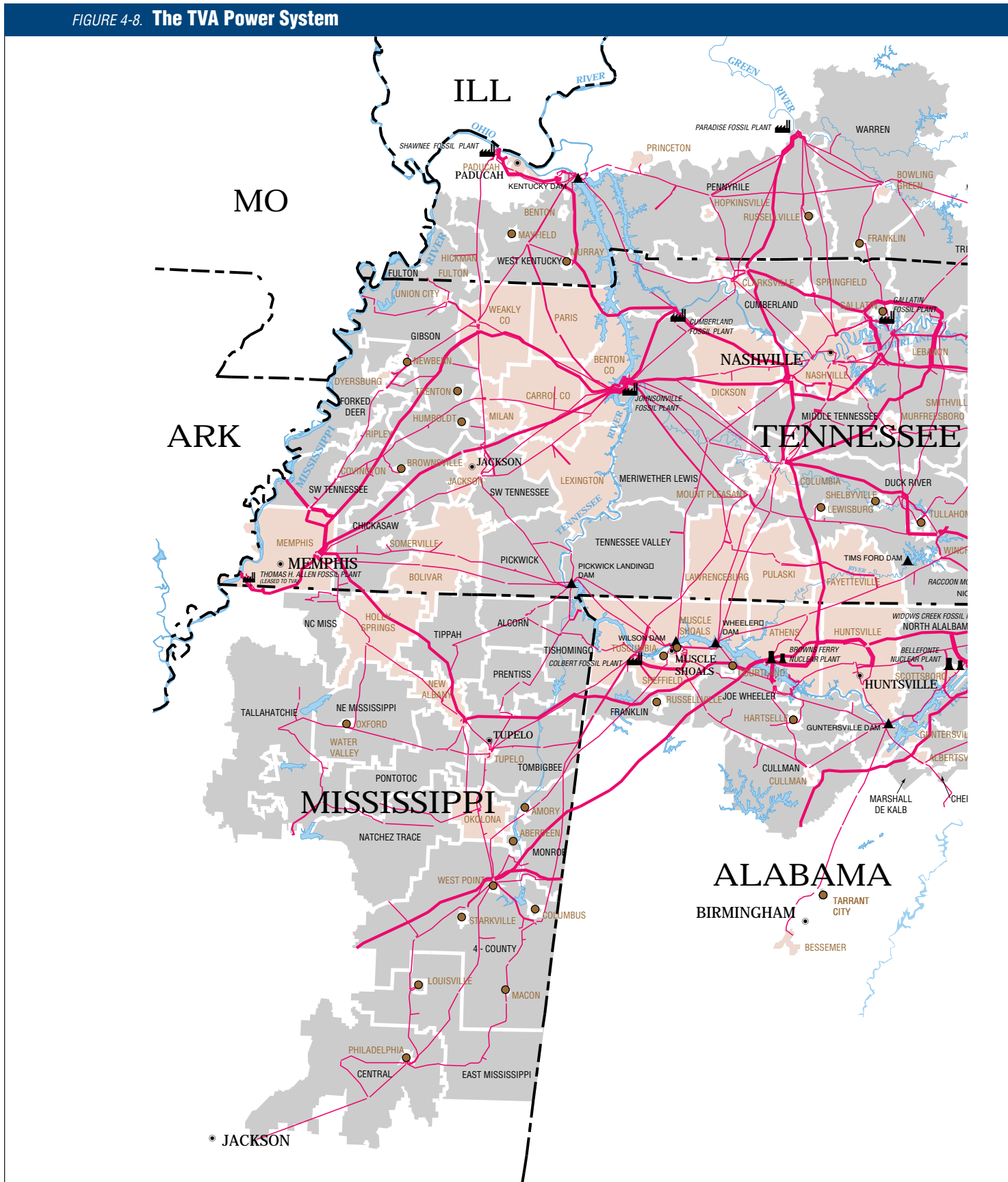
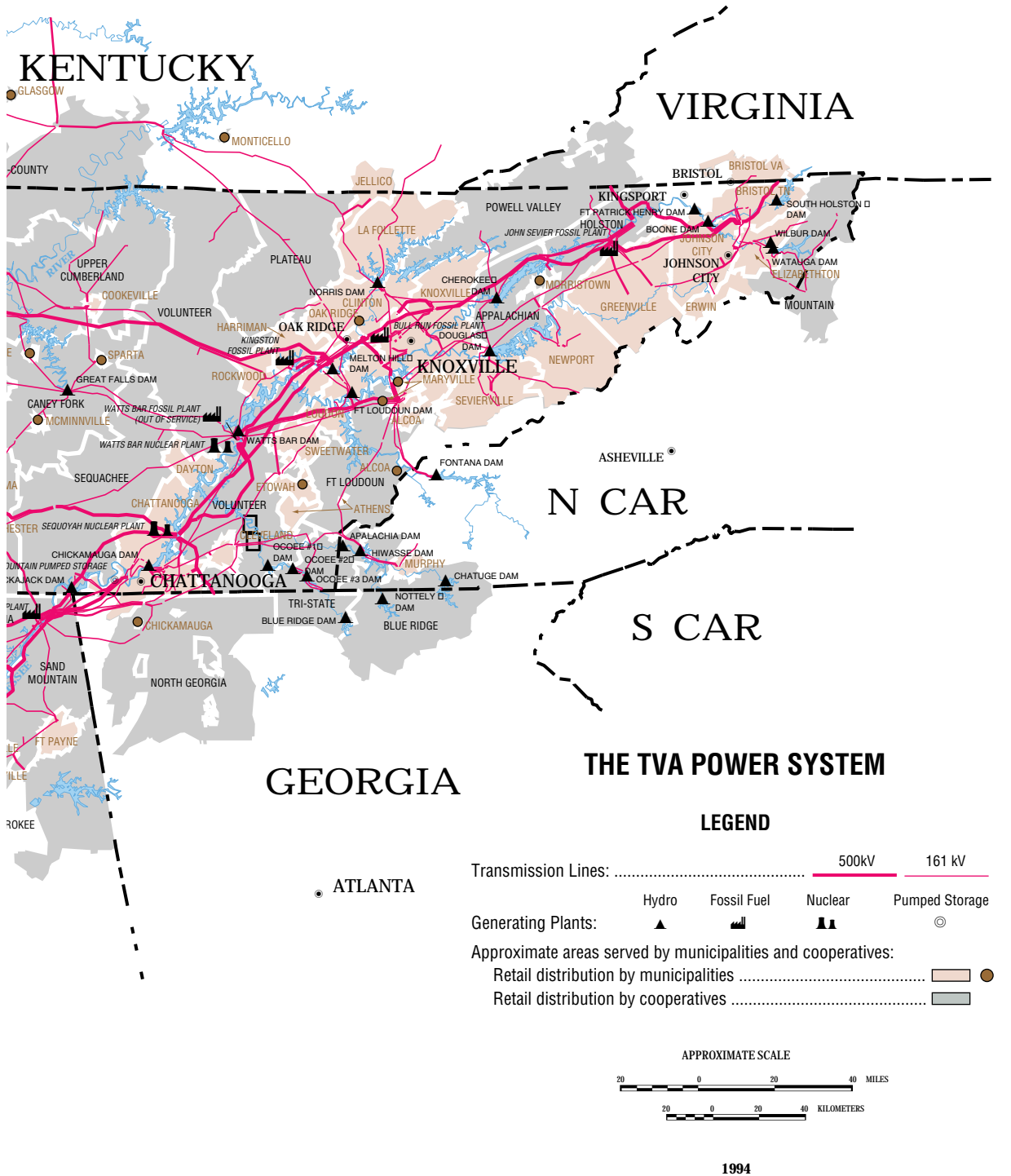


FIGURE 4-8. The TVA Power System

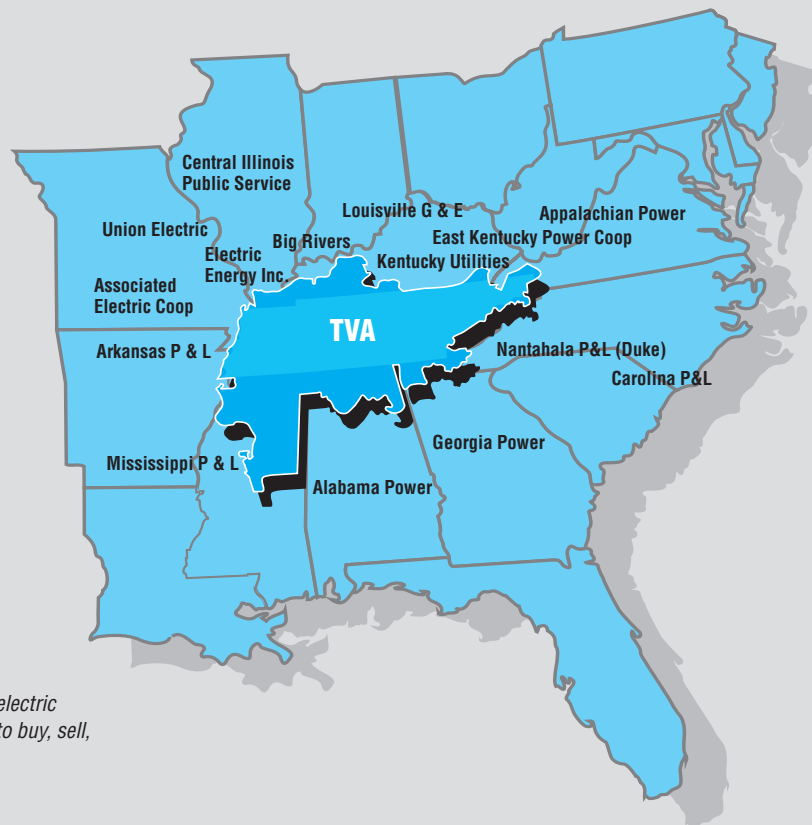




MAPS PREPARED BY TVA GEOGRAPHIC INFORMATION AND ENGINEERING

FIGURE 4-9. Interconnections with Other Utilities

- Associated Electric Coop
- Appalachian Power
- Big Rivers EC
- Carolina P&L
- Central Illinois Public Service
- East Kentucky Power Coop
- Electric Energy Inc.
- Entergy Services
 - Arkansas P & L
 - Mississippi P & L
- Kentucky Utilities
- Louisville Gas & Electric
- Nantahala P&L (Duke)
- Southern Company
 - Alabama Power
 - Georgia Power
- Union Electric



TVA has interties with 13 neighboring electric systems, which allows these systems to buy, sell, and wheel power.

and nuclear), and the approximate areas served by the 160 power distributors (municipalities and cooperatives).

Figure 4-9 shows the 13 neighboring utilities that TVA has interconnections with to buy, sell, and wheel power.

TVA's Financial Condition and Results of Operation

Since 1988, actions taken by TVA to reduce its costs and interest expense have allowed it to keep electric rates at the level they were in 1987. The TVA Board approved an eighth year of stable electric rates for TVA customers on September 21, 1994. TVA has been able to do this by refinancing its debt, reducing its workforce, and improving the efficiency of its operations.

FINANCIAL RESULTS OF OPERATION

Revenue

Operating revenues were \$5.4 billion for fiscal year 1994. Total energy generated was 134 billion kilowatt-hours for 1994, which was 3.4 percent higher than the previous year. This increase was due to growth in sales to

municipal and cooperative distributors, direct served industries, federal agencies and off-system sales.

Operating Expenses

Operating expenses for fiscal year 1994 were \$3.5 billion; fuel expenses accounted for \$1.5 billion of this total. Non-fuel operating expenses were \$2 billion. Operating and maintenance expenses for 1994 were \$1.1 billion, compared to \$1.2 billion for 1993. The decrease in operating and maintenance expenses reflects continuing efforts to reduce costs.

Depreciation and amortization costs were \$639 million in fiscal year 1994, an increase of \$182 million compared to fiscal year 1993. The increase was attributable to the amortization of deferred charges, additions to completed plants, and an increase in the composite depreciation rate.

Interest Expense

Interest expense for fiscal year 1994 was \$1.9 billion, an increase of \$76 million compared with 1993. The increase was the result of additional borrowings related to financing TVA's power program. In 1994, TVA refinanced \$5 billion of existing long-term debt to save \$65 million in annual interest expense. Since refinancing efforts were begun in 1989, TVA has achieved \$317 million in interest expense savings.

Earnings

TVA's power program consists primarily of the generation, transmission, and sale of electricity. Net income for fiscal year 1994 was \$151 million.

Figure 4-10 summarizes TVA's statement of operations and retained earnings for 1994, 1993, and 1992.

FIGURE 4-10. Financial Statement

	Millions of Dollars		
	1994	1993	1992
OPERATING REVENUES	\$5,401	\$5,276	\$5,065
OPERATING EXPENSES			
Fuel and purchased power, net	1,493	1,401	1,354
Operating and maintenance	1,081	1,174	1,098
Depreciation and amortization of deferred nuclear costs	639	457	505
Tax equivalent payments	248	237	241
Total operating expenses	3,461	3,269	3,198
Operating income	1,940	2,007	1,867
OTHER INCOME AND DEDUCTIONS, net	(59)	23	(87)
Income before interest charges	1,881	2,030	1,780
INTEREST CHARGES			
Interest expense	1,853	1,777	1,695
Allowance for funds used during construction	(123)	(58)	(35)
Net interest charges	1,730	1,719	1,660
NET INCOME	151	311	120

This figure summarizes TVA's income and operating expenses for fiscal years 1992, 1993, and 1994. Net income for fiscal year 1994 was \$151,000,000.

CONTROLLING THE TVA DEBT

Concern about TVA's debt was one of three major issues identified by the public during scoping meetings held as part of Energy Vision 2020. Other major concerns were TVA's nuclear program and TVA's ability to remain competitive.

In the opinion of many TVA customers and members of the public, high debt is generally associated with a poor competitive position. Since the large capital expenditures necessary to complete TVA's nuclear units will increase

TVA's debt, completing these units contributes to a perception that TVA's competitiveness will suffer. With the rapid evolution of the utility industry into a competitive environment, many utilities are trying to improve their debt structure so that the pricing of electricity can be more flexible in response to future uncertainty. Clearly, with the increasing risk of TVA losing customers to other utilities, prudent business practices suggest that debt be carefully managed and controlled.

TVA's debt limit, as set by Congress in the TVA Act, is \$30 billion. TVA's current debt is some \$3 billion below this debt ceiling. The TVA Board has announced plans to establish a self-imposed debt limit \$2-3 billion below the \$30 billion allowed by Congress. This internal limit on debt will be formally reviewed periodically to ensure that the limitation meets TVA's continuing business needs. However, one of the major constraints utilized in Energy Vision 2020 was to keep the debt for any feasible resource plan within these limits.

TVA's Electric Rate Structure

The rates for TVA power must be adequate to meet power system needs and be as low as feasible. TVA's rate structure must also respond to customer needs. TVA develops wholesale rates for the distributors (who, in turn, serve most end users) and for large directly served industrial customers.

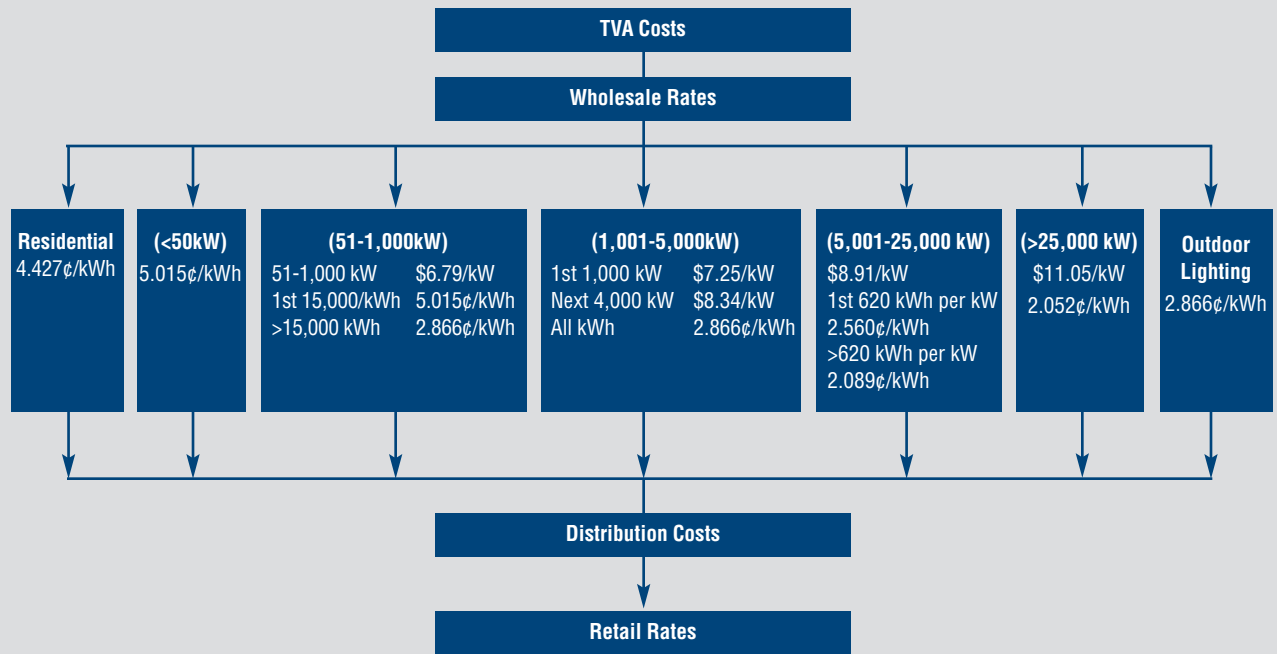
Working with the distributors of TVA power, a major restructuring of TVA's rate design was begun in 1988. This was done in an effort to simplify and improve the way TVA applied power rates.

Specific objectives of the rate restructuring were to:

- Encourage efficient operations
- Provide stable and predictable margins
- Support quality service
- Be competitive
- Be cost-of-service based to ensure equity and avoid discrimination
- Be as simple as possible
- Provide consistent price signals
- Encourage the efficient use of resources
- Encourage economic development of the TVA region as a whole
- Be responsive to changing customer needs

As a result of this restructuring, an "end-use wholesale rate" was developed. This wholesale rate has separate charges for residential and general service end-use groups. General service includes 6 classes of customers: those with demands less than 50 kilowatts, between 51 and 1,000 kilowatts, 1,001 to 5,000

FIGURE 4-11. TVA Rate Structure



Wholesale power rates are based on the cost of service for different classes of customers. Distribution cost is added to the wholesale rate by distributors of TVA power to determine the end-use retail price of electricity.

kilowatts, 5,001 to 15,000 kilowatts, 15,001 to 25,000 kilowatts, and demand greater than 25,000 kilowatts. Power rates for large industrial customers with demands greater than 25,000 kilowatts are the same whether they are served by a distributor or directly by TVA. *Figure 4-11* illustrates TVA's rate structure.

As part of the end-use wholesale rate implementation, distributors were provided the flexibility to design retail rates. Distributor retail rates include the end-use wholesale charge paid to TVA, along with the distribution costs for their individual systems.

Even though distributors design their own retail rates, TVA reviews and approves the rates before application. This review is to ensure that the rates are consistent with the requirements of the TVA Act.

Several optional rate arrangements are available for commercial and industrial consumers. These include Economy Surplus Power, an interruptible rate, and the Enhanced Growth Credit, a program that provides power bill credits for new and expanding industries.

